BIOFOULING COMMUNITY DYNAMICS IN LOUISIANA SHELF OIL PLATFORMS IN THE GULF OF MEXICO

by Robert Y. George and Philip J. Thomas

ABSTRACT

This paper presents the quantitative results on the standing stock and population densities of the fouling community on the submerged oil platform structures in the area of the Offshore Ecology Investigations on the Louisiana Shelf. Climax fouling community was investigated on the basis of quantitative samples and *in situ* photographs. Patterns in biomass and density of seasonal fouling settlement were explained on the basis of periodic examination of *in situ* test panels. Oil platforms act as artificial reefs, offering large submerged surfaces for promoting biofouling growth in this environment. Comparisons of conditions today with baseline information obtained two decades ago from platforms point out some faunal changes. Vertical zonation in types of sessile foulers in Exxon Platform 54A suggest the dominance of the barnacle-*Enteromorpha* community in the tidal and surge zone; the hydroid-barnacle community in the submerged zone, and the hydroid *Bougainvillia*-serpulid community in the near-bottom turbid zone.

INTRODUCTION

In the photic zone of the continental shelf environment, submerged hard surfaces have been known to form an ideal base for the develop-

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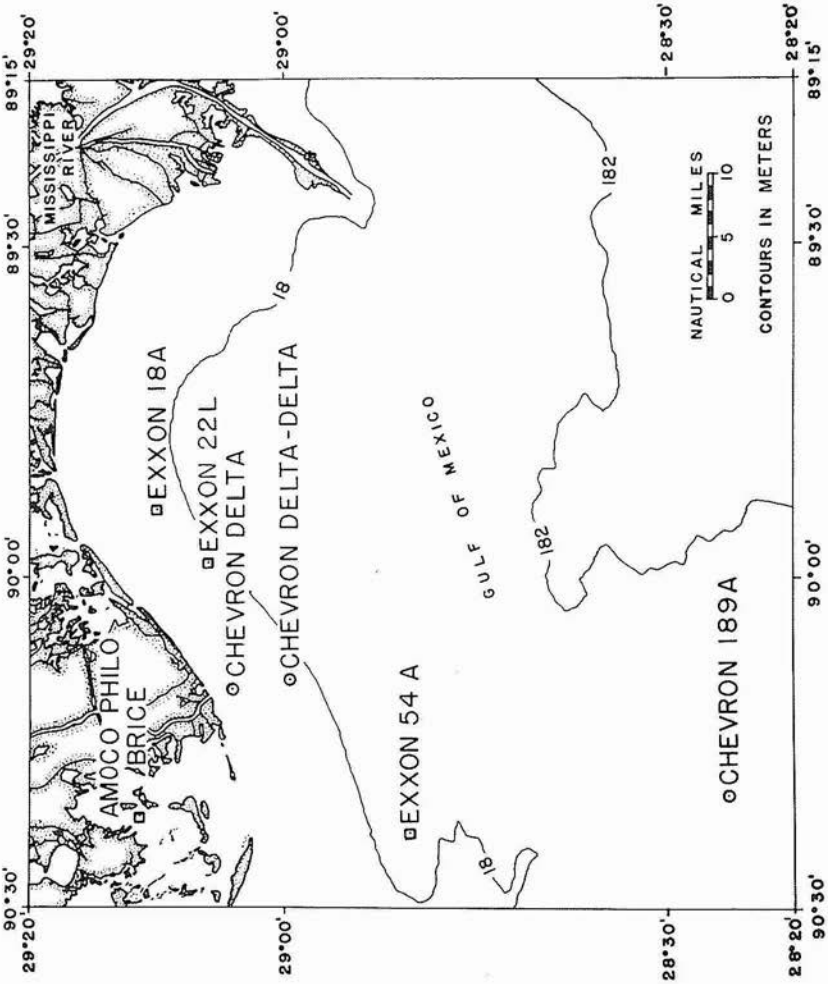

FIG. 1. MAP OF STUDY AREA.

ment and establishment of the fouling community. Therefore, the submerged structures of oil platforms present a suitable substratum, as an artificial reef, offering surface for successful settlement for all types of sessile organisms. This settlement eventually constitutes a mat of sessile plants and animals, which in turn offers shelter and food for a variety of motile organisms such as crabs, amphipods, isopods, polychaetes, and fish. The chlorophyll-bearing phytobenthos, including the filamentous algae *Enteromorpha* spp. and sessile diatoms, are the primary components of this fouling community in the tidal-splash zone of the platform structures. The animal components include both herbivorous and carnivorous organisms. The biofouling growth seems to prevail from the surface to the bottom as deep as 43 m in Gulf of Mexico platform structures. The growth attracts grazing fishes, which provide a renewable food supply for carnivorous fishes that are of recreational and commercial importance.

Biofouling studies on oil platform structures are limited. In the Gulf of Mexico two studies have been conducted on offshore fouling communities. Gunter and Geyer (1955) investigated the composition and abundance of these organisms in near-shore platforms off Grand Isle, Louisiana. Pequegnat and Pequegnat (1968) carried out studies on offshore fouling off Panama City, Florida.

The fouling community on seven different producing oil platforms, including one of those sampled by Gunter and Geyer, was examined in this study (figure 1). We investigated the effects of environmental changes such as the 1973 flood, the role of platforms as artificial reefs, the standing stock and seasonal trends, and the vertical and horizontal patterns of biofouling growth. The fouling community on oil platforms is an integral part of the Louisiana shelf biota, a status that developed after the introduction of these man-made structures, which offered large surfaces for the settlement of organisms. Sessile foulers can be used to estimate the possible impact of oil-production activities. Our study is therefore an important reference base for future evaluation of possible environmental impact.

METHODS AND MATERIALS

The quantitative data on the biofouling growth on oil platorms were obtained by three methods. Quantitative samples were taken of a known area of climax fouling growth at various depth levels from the submerged oil platform legs. A diver-operated scraping device (figure 2) was strapped around the platform leg and the biofouling growth was scraped with the movable blades and collected into an attached bag. The sample

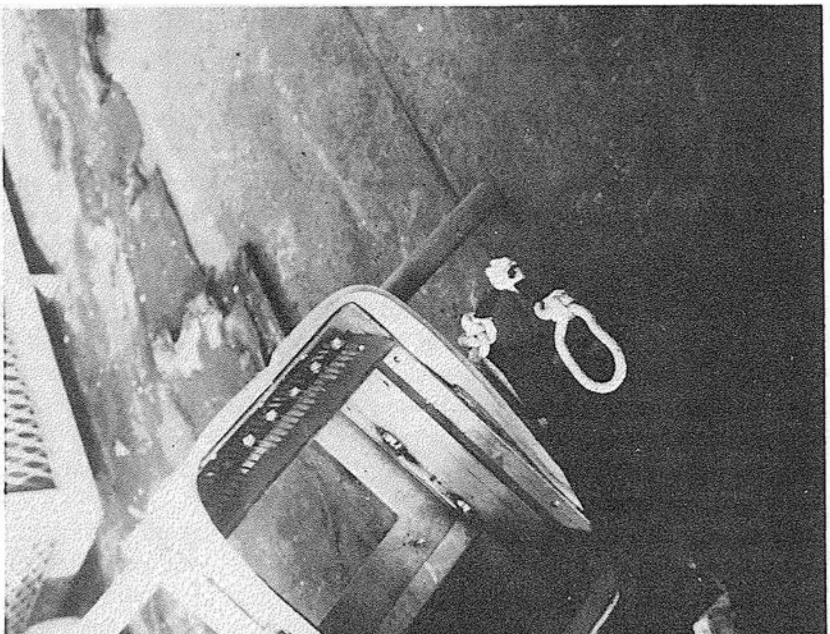

FIG. 2. THE DIVER-OPERATED SCRAPING DEVICE used for obtaining samples of fouling growth from submerged platform legs.

was sorted and estimations made on species composition, biomass, and density. The scraping sampling was done in all four seasons from the same platforms at similar depths.

An *in situ* photographic survey of biofouling growth on platform legs was made by divers using a Nikonas camera with a special close-up lens. The photographs were enlarged and analyzed for types of fouling organisms on platform legs from various depths.

For the third type of sampling, Plexiglas test panels (15 cm $\times$ 5 cm $\times$ 0.6 cm = total surface area of 174 cm^2) were suspended from surface to bottom beneath four different platforms at intervals of one meter. The test panels were located on an Amoco platform in the bay; on the near-shore Chevron Platform Delta; on Chevron Platform Delta Delta in the Bay Marchand area; and offshore on Chevron Platform 189A. The test panels were exposed for fouling growth during spring, summer, fall, and winter of the year 1972-73 for seasonal estimations of kinds and quantities of biofouling growth. The hydrographic data in the vicinity of platforms come primarily from Oetking (1973).

RESULTS

Fouling communities on platforms

Samples were analyzed by evaluating biomass and population density of the community and the member species. The summer sample was taken on July 11, 1973, when the water temperature had a mean value of 23° C at the bottom at 16.8 m and 30° C at the surface. The winter samples were collected on January 17, 1974, with the water temperature ranging between 18° and 19.5° C. The salinity of the water showed significant dilution in the summer of 1973, with a low of 17.8 ppt at the surface and a mean bottom salinity of 36.2 ppt. Salinity in the winter months ranged from surface to bottom between 31 and 34 ppt (Oetking 1973). The biological changes in the fouling community were examined in light of the fluctuations in the physical environment. Seasonal fluctuations in the climax community were subtle for the sessile foulers but well-marked in motile organisms and algae. Sessile acorn barnacles were the dominant organism at all depths (tables 1 and 2). Among the motile animals, the dominant amphipods in the climax community during the summer were mainly *Corophium acherusicum* and *Stenothoe* sp., but in the winter months caprellids and gammarids were the dominant forms. Algal biomass in the surface diminished during the winter months from 85.6 g/m^2 in summer to 24.5 g/m^2 in the winter. The biomass and density of the fouling species in the summer and winter period are tabulated for each group in tables 1 and 2.

Table 1

Biomass and Density of Fouling Organisms
at Exxon 18 "A" on February 17, 1974

Type of Organism	2.4m		9.1m		12.8m	
	No./m^2	g/m^2	No./m^2	g/m^2	No./m^2	g/m^2
Barnacles	1390	5233.3	900	1525.1	50	30.0
Algae	++	24.5	--	--	--	--
Anemones	5120	49.7	10890	102.7	--	--
Amphipods	3440	16.5	35880	37.8	--	--
Polychaetes	3560	25.2	2800	36.1	475	0.5
Crabs	240	53.7	180	57.1	--	--
Copepods	--	--	750	7.4	--	--
Bivalves	40	5.9	12	2.1	--	--
Hydroids	--	86.5	--	18.9	--	3.5
Sponge	--	163.1	--	81.6	--	--
Bryozoa	--	2.8	--	1.1	--	4.0
Total Biomass		5661.2		1869.9		38.0
Sediment		289.8		202.4		24.5

Bathymetric Zonation of Climax Fouling Community on Exxon Platform 54A. The vertical zonation patterns of the fouling mat in all of the platform samples appeared to show similar qualitative distribution. A generalized picture of the major fouling assemblages of a platform leg from Exxon 54A is as follows: At the surface, just below mean high tide level, the outer covering of the fouling mat is dominated by the green algae *Enteromorpha.* The thickest concentration is usually in the upper 5 cm, with the algae rapidly diminishing below one meter, and only found in patches down to 4.6 m. Interspersed within the algal growth are the hydroids *Syncoryne*, and small motile animals, such as the amphipods *Corophium*, xanthid crabs *Neopanope texana*, and pycnogonids. The barnacles, underneath the filamentous growth, are *Balanus reticulatus* and *B. improvisus* in a 55-45 ratio. The barnacles are usually somewhat smaller (approximately 1-5 mm) than those found deeper.

Table 2

Biomass and Density of Fouling Organisms at Exxon 18 "A" on July 11, 1974

Type of Organism	2.4m		9.1m		12.8m	
	No./m^2	g/m^2	No./m^2	g/m^2	No./m^2	g/m^2
Barnacles	2600	5069.3	925	2769.2	50	43.2
Anemones	2010	18.8	36925	42.4	50	0.1
Amphipods	21700	8.8	10375	2.5	--	--
Polychaetes	825	1.5	200	0.2	550	0.5
Crabs	25	1.3	325	3.0	--	--
Flatworms	--	--	100	0.1	--	--
Isopods	--	--	--	--	50	0.5
Hydroids	--	11.5	--	13.4	--	3.5
Sponge	--	10.9	--	24.8	--	--
Bryozoa	--	18.4	--	12.4	--	4.0
Total Biomass		5140.5		2868.0		48.8
Sediment		362.3		162.2		30.2

The algae-hydroid fouling mat is replaced by the sea anemones, *Aiptasia,* at depths of 2.4 to 6 m. The barnacles are larger, with the ratio of *B. reticulatus* to *B. improvisus* increasing to 70-30. *B. eburneus* is occasionally found intermixed with these barnacles but composes less than 1% of the total population. The amphipods *Corophium, Stenothoe,* and *Caprella,* xanthid crabs, and the blemmy *Hypleurochilus* dominate the motile fauna at this depth.

Hydroids dominate the outer covering of the barnacles below 7.5 m. The barnacles are found in diminishing patches from 7.5 to 10.7 m. *Balanus reticulatus* completely dominates the barnacle fauna, with only a few *B. improvisus*; *B. tintinnabulum* is present in patches and usually as empty shells.

The fouling fauna is completely dominated by hydroids from 12.2 m to the bottom. A few scattered, empty shells of *B. reticulatus* are present, but no living barnacles were recorded. A few serpulid worm

Table 3

Biomass (g) of Fouling Organisms Expressed in Terms of Each Quantitative Scraping Sample of 400 cm^2. Humble Platform 54A.

Species	Surface		2.4m		6.1m		12.2m		Total	
	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.	Biomass	No.
Algae										
Polysiphonia sp.	+	+	+	+					+	+
Enteromorpha sp.	+	+	+	+	+	+			+	+
Coelenterata										
Syncoryne sp.			+	+					+	+
Bougainvillia tennella							+	+	+	+
Bundosoma cavernata							.05	7	.05	7
Ectoprocta										
Bugula neritina			+	+					+	+
encrusting sp. 1							8		8	
Sipunculida										
Sipuniculid sp. 1	.07	1			.04	1			.11	2
Annelida										
larval polychaetes			.04	13	.01	1	.01	3	.06	17
Mollusca										
Lithophaga aristata							.56	2	.56	2
Arthropoda										
Balanus reticulatus	140	490	120	420	100	350	29	101	389	1361
Neopanope sp.	.47	8	.03	3	.03	3	.1	1	.66	15
Synalpheus townsendi			.36	4	.13	3	.06	2	.55	9
Chordata										
Tunicate sp. 1					19	+			19	+
Hypleurochilus geminatus			.25	2					.25	2
Total Biomass	140.47		120.68		119.21		37.78		399.69	

tubes were found in the near-bottom zone, which is apparently under the intermittent influence of the turbid layer observed during the OEI investigations (Oetking 1973).

The biomass distribution of the total fouling growth shows a depth-related trend with abrupt decrease beyond 12.2 m (table 3). Such a sharp fall in biomass with increase in depth, which is correlated with the population of *B. reticulatus*, is also seen in the fouling biomass in two other adjacent Exxon oil platforms, 63A and 22L (figure 3).

Acorn Barnacles on Louisiana Oil Platforms. Four species of barnacles were encountered in the fouling studies, all of which belong to the genus *Balanus: B. reticulatus*, *B. improvisus*, *B. eburneus*, and *B. tintinnabulum*. The dominant species on the oil platform legs was *B. reticulatus*; this is the first record of it from the Louisiana coast. This species was absent from the barnacle faunal lists of Henry (1954), Gunter and Geyer (1955), Wells (1966), and Pequegnat and Pequegnat (1968). *B. reticulatus* was found at all stations and at all depths (0-18.3 m), predominantly above the 10.7 m depth on the Louisiana offshore platforms. It ranged in size from 2 to 30 mm in diameter. *B. reticulatus* dominated the growth on the test panels during the summer months. It was rarely found in January and completely absent in the spring. These data suggest a breeding and settlement cycle between May and December that corresponded to Utinomi's (1967) records. The height was between 3 and 20 mm with specimens ranging from 10 to 17 mm in diameter.

The second most abundant species of barnacles was *B. improvisus*, which is well known in the Gulf (Henry 1954). This barnacle was present at all stations, but restricted to the upper 9.1 m on the pilings. It grew on the shells of *B. reticulatus* and was rarely observed directly attached to the platform leg. Apparently, off the Louisiana coast *B. improvisus* is restricted by competition from *B. reticulatus*, a situation similar to the interaction of *B. improvisus* and *B. balanoides* in the Massachusetts coast, where *B. balanoides* is dominant over *B. improvisus* (Zullo 1963, 1966). In the test panel studies, *B. improvisus* was found to dominate only in the January and March samples, reflecting a winter breeding and settlement cycle. This cycle corresponded with the breeding cycle observed by McDougall (1943), but conflicted with the data reported by Vissicher and Luce (1928) from North Carolina. Gunter and Geyer reported larval settlement in all seasons of the year, and Pequegnat and Pequegnat similarly found the species settling throughout the year. Therefore, *B. improvisus* in the Gulf of Mexico is capable of seasonal breeding, but settlement of larvae is restricted to the winter months because of competition from *B. reticulatus*.

B. eburneus was the third species encountered occasionally on the

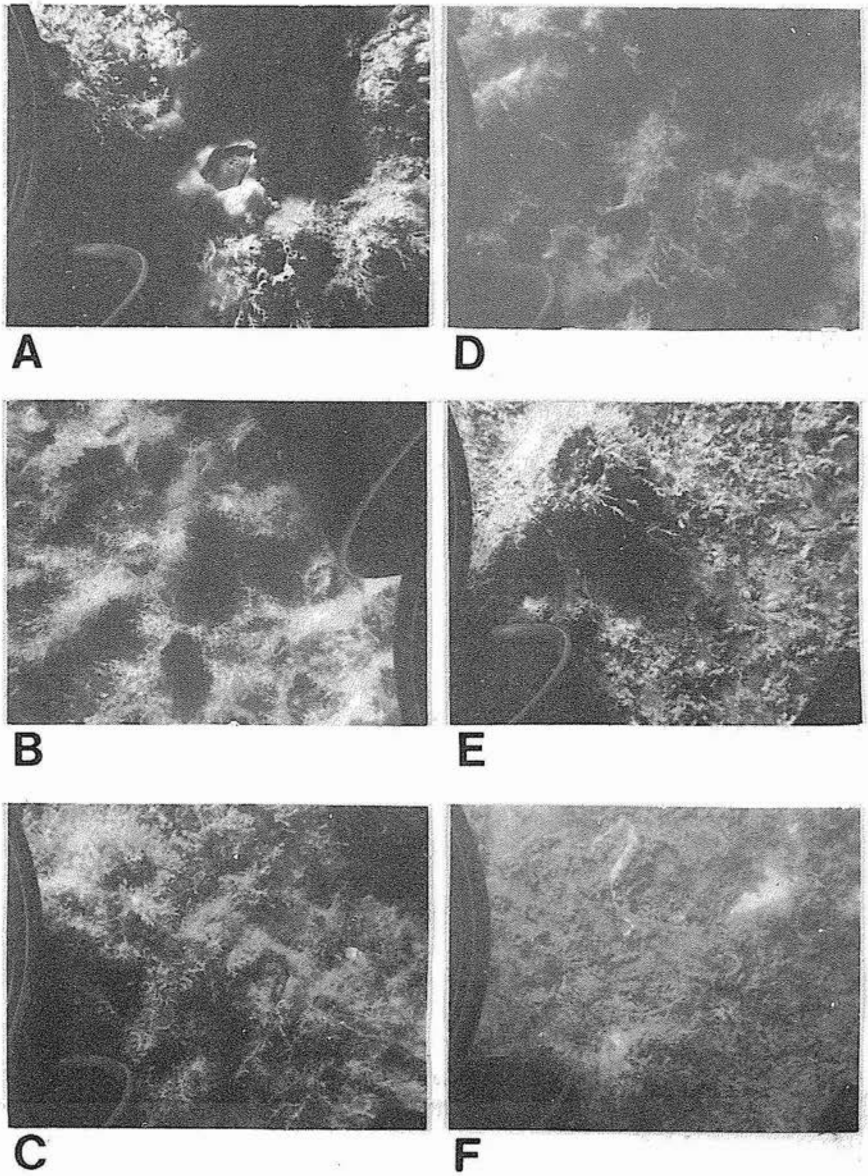

FIG. 3. CLOSEUP *IN SITU* PHOTOGRAPHS OF FOULING GROWTH ON PLATFORM LEGS. Platform CAGC-G1-63A, April 3, 1973: (a) 1.5 m; (b) 7.6 m; (c) 10 m; (d) 13.4 m; (e) 30.5 m; (f) 27.1 m.

platform legs in depths from 3 to 9 m. The few specimens recorded were 18-25 mm in size and were usually growing in between *B. reticulatus*. A few specimens of *B. tintinnabulum* were also observed on Exxon Platform 54A, but all specimens were dead; the empty shells measured 40-60 mm. All four barnacle species are shown in figure 4.

This analysis of the distribution of the four acorn barnacle species indicates an invasion of *B. reticulatus* as a new colonizer to the Louisiana shelf environment. The dominant nature of *B. improvisus* in certain seasons is also evident. *B. eburneus* and *B. tintinnabulum* are much less frequently found on offshore platform legs.

Seasonal Impact of Spring Flood on Settling Fouling Community on Oil Platform Delta. The fouling community was examined quantitatively before and after the 1973 spring flood at the near-shore Platform Delta and the Timbalier Bay platform. Significant changes in both density and biomass occurred during the post-flood periods when the waters were diluted down to 15-25 ppt. This condition facilitated the migration of euryhaline bay populations into the inner shelf environment. This trend was clearly noted in the pronounced increase in biomass and density of populations in a comparison between the pre-flood and post-flood conditions in 1973 at the near-shore Platform Delta. The total biomass of settling fouling community ranged between 100 and 550 g/m^2 in spring 1973 and increased to 2500-6500 g/m^2 in the summer. The summer development of fouling organisms on this near-shore platform in the warm and less saline period of summer 1973 was attributed to the influence of the flood and subsequent introduction of euryhaline fouling species into the inner shelf environment. A marked decrease in both biomass and density was encountered subsequently in fall 1973 when the biomass ranged between 100 and 900 g/m^2. These changes suggest that seasonal variation in the standing stock of the fouling community in the Louisiana shelf oil platform is hydrographically regulated by the flux of water from the coastal bays and Mississippi River, or by the increase in water, or by a combination of these two factors.

Fouling communities on test panels

Bathymetric Zonation of Settling Fouling Community. The fouling community structure on Platform Delta was based on quantitative analysis of biomass at various depth levels (figure 5). It is evident that the fouling community is strikingly different in composition between surface and bottom. Barnacles compose about 25% of the biomass at the surface and increase to about 55% between 1.2 and 4.9 m, followed by a decrease to zero at the bottom. However, empty barnacles were encountered in greater density at mid-depths and at the bottom. Test panels

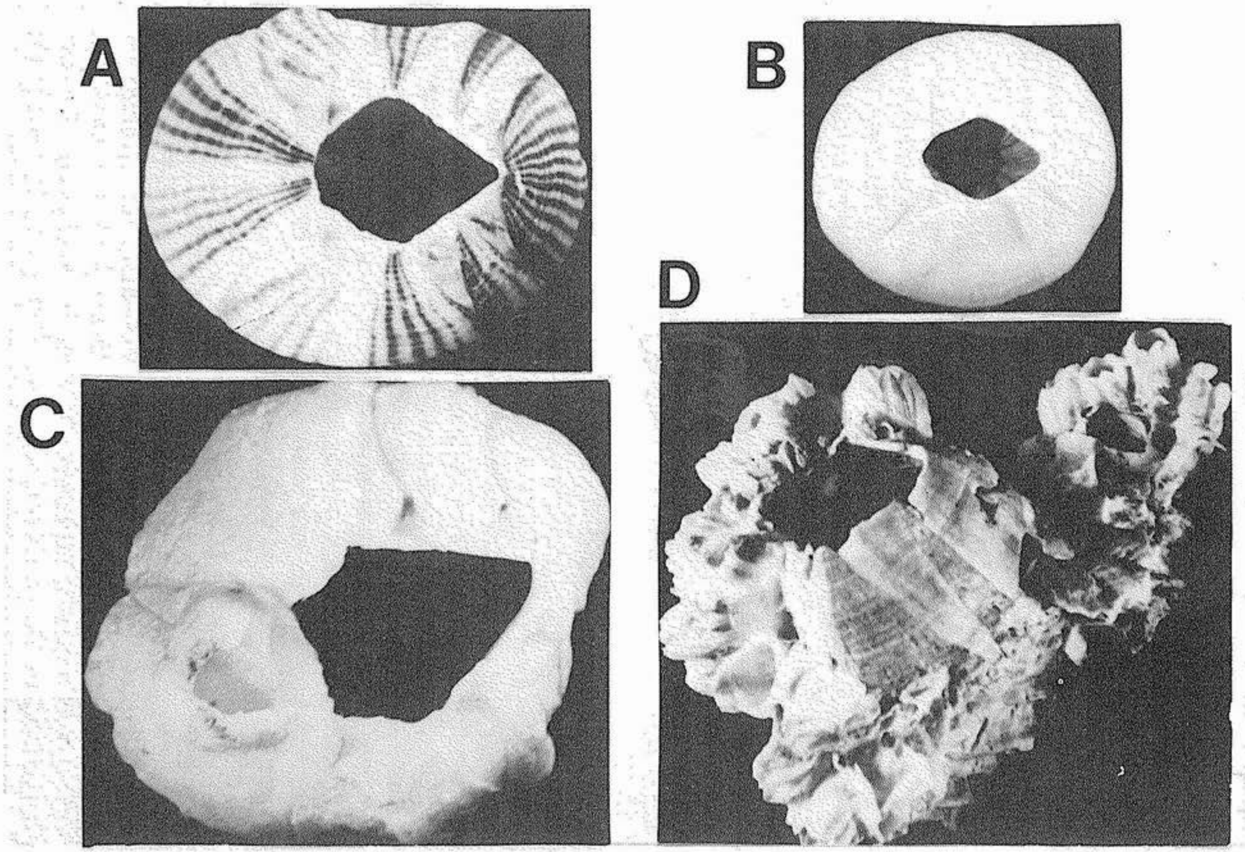

FIG. 4. THE FOUR BARNACLE SPECIES ENCOUNTERED IN THE BIOFOULING GROWTH ON LOUISIANA OFFSHORE OIL PLATFORMS: (a) *Balanus reticulatus*; (b) *B. improvisus*; (c) *B. eburneus*; (d) *B. tintinnabulum*.

submerged for 60 days contained such empty shells of about 2.5 cm in diameter, suggesting an initial rapid growth of barnacles following settlement. The ratio of living to dead barnacles showed a relationship with depth and water characteristics. A three-layered vertical water structure was recognized with murky conditions occupying the surface layer, clear water in the middle zone, and a turbid layer on the bottom. The decrease in biomass with increase of depth seemed related to water characteristics, with evidence of diminished growth in the turbid layer zone. Encrusting bryozoans became more numerous as the population of barnacles declined.

The distribution of the two common amphipods at the Chevron Platform Delta Delta seemed to be depth-related. *Corophium* sp. reached its density peak in the upper 3 m and *Caprella* sp. was less common. In the mid-depths, both species were equally represented, and at depths beyond 10.6 m *Caprella* sp. reached its dominance and *Corophium* sp. declined. Both species are evidently competitors and separation of them by depths suggests a biological equilibrium dependent upon food or habitat.

Comparison of Inshore and Offshore Fouling Community. The relationship of distance from the shore and standing stock of the fouling community on platforms was examined on the basis of biomass of settlement. The data for the inshore oil platform were obtained from an Amoco platform located in the northern part of Timbalier Bay near Philo Brice Island. The water is 2.4-3 m deep; salinity ranged from 20 to 28 ppt in 1972-1974, and temperature ranged between 8° and 29° C. The biomass averaged 4175 g/m^2 at the surface, 3108 g/m^2 at 1 m, 2336 g/m^2 at 1.8 m, and 84 g/m^2 below 2 m (figure 6). The water in the bay was turbid and the low biomass in the bottom depth was probably the result of the suspended sediments and high turbidity. The total biomass was high at the surface, with green algae *Enteromorpha* constituting 20% of the biomass. Barnacles were the dominant member of the inshore fouling community with a population of $60{,}402/m^2$, followed by polychaetes ($56{,}781/m^2$) and the flatworm *Leptoplana* sp. with $20{,}747/m^2$. This flatworm occurred only in the Timbalier Bay fouling community and was not encountered offshore.

Three platforms were compared to determine the function of the distance from shore on the settlement of organisms on test panels. The platform near Philo Brice Island was used for the Timbalier Bay station. Bay Marchand oil platform is located four miles from shore and is within the influence of the Mississippi River. Chevron Platform 189 (see figure 1) is located 45 miles from shore in the blue water zone of the Gulf and is probably outside the influence of the Mississippi River

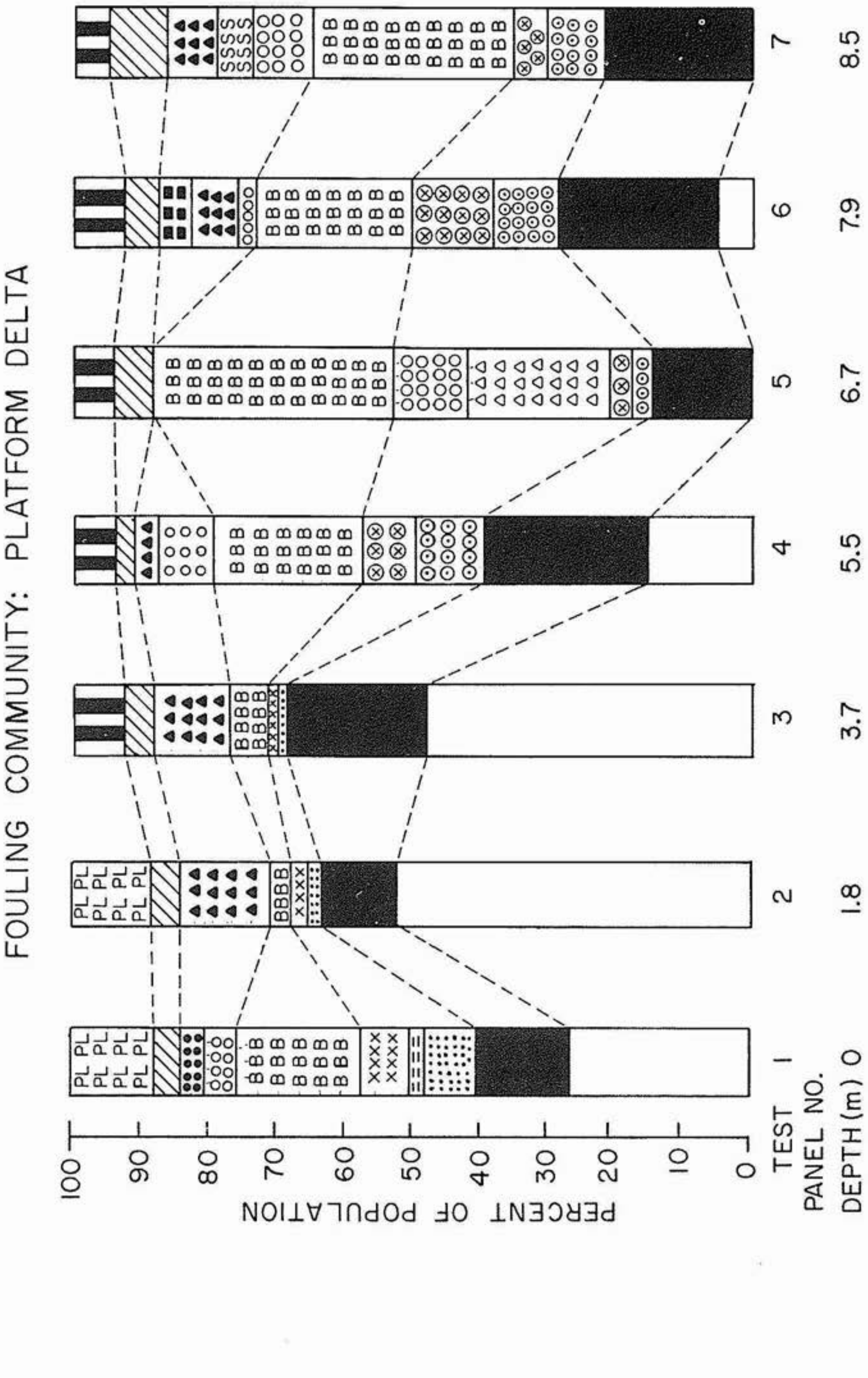
FOULING COMMUNITY: PLATFORM DELTA
PERCENT OF POPULATION
100
90
80
70
60
50
40
30
20
10
0
TEST PANEL NO.
DEPTH (m)
1 2 3 4 5 6 7
0 1.8 3.7 5.5 6.7 7.9 8.5

FIG. 5. BIOMASS STRUCTURE OF FOULING COMMUNITY based on quantitative analysis of fouling growth after 60 days exposure at 7 different depth levels beneath Chevron Platform Delta. Percentage representation of various taxa is given for each test panel. Code for symbols used is as follows:

- Living barnacle *Balanus reticulatus*
- Dead barnacle *Balanus reticulatus*
- Bryozoan *Bugula neritina*
- Chlorophyta - filamentous alga *Enteromorpha* sp.
- Hydroid *Bougainvillia tenella*
- Hydroid *Syncoryne* sp.
- Sea anemone sp. #2
- Sea anemone sp. #3
- Polychaete
- Decapod Xanthid crabs
- Crustacean larvae
- Amphipod *Caprella* sp.
- Tunicate unidentified
- Appendages, Mucus and Moults
- Sediment and accumulated debris from suspended matter

Total biomass ranged from 4150 g/m^2 at the surface to 1740g/m^2 at the bottom.

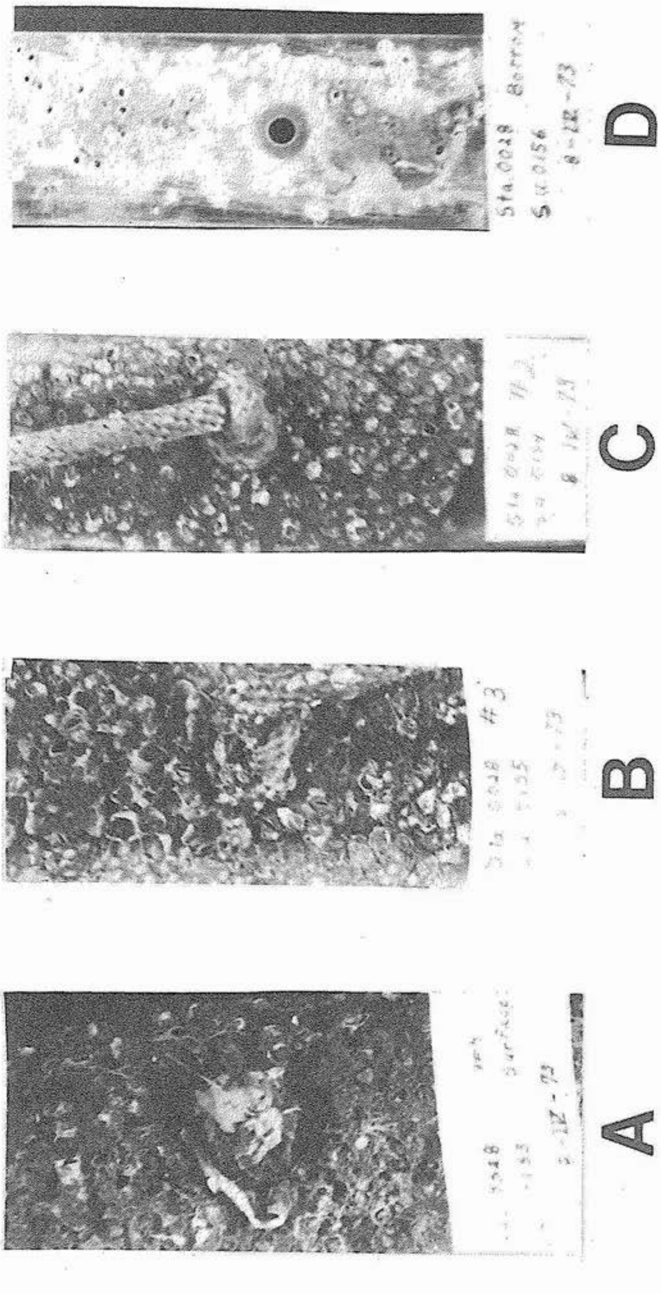

FIG. 6. ASSEMBLAGE OF PHOTOGRAHS OF *IN SITU* TEST PANELS showing fouling growth in summer 1973 at the Amoco oil platforms at Timbalier Bay. Note the reduced fouling settlement near the mud bottom: (a) surface; (b) 0.9 m; (c) 1.8 m; (d) 2.7 m.

plume. The species distribution from the three platforms is given in table 4. The greatest diversity of life was present at the near-shore platform, where nearly twice the number of species were present as at the other two sites. The increase in number of species at the near-shore station was equally divided between sessile and motile organisms. The biomass, in contrast, was greatest at the offshore platform. Three species of grazing fish, the sheepshead *Archosargus probatocephalus*, spade fish *Chaetodipterus faber*, and trigger fish *Balistus capriscus* were commonly found at the near-shore platform, and the red snapper *Lutjanus campechanus* was observed at the offshore station.

DISCUSSION

These studies of the fouling communities of the oil platforms clearly demonstrate the large amount of biomass present on these structures. Since each platform averages about 0.6 hectares of surface area, and since there are over 1500 of these structures in the OEI area, these represent a total of 900 hectares of surface area available for settlement of fouling organisms. If the minimum and maximum values of biomass of 100 to 8000 g/m^2 are used to calculate the total amount of biomass, then the quantity of fouling organisms present on the platforms of the OEI area ranges from 9×10^8 to 7.2×10^9 g total for all structures. Therefore, this extensive surface area with luxuriant fouling growth out to at least 50 miles offshore acts as a reef, resulting in the aggregation of fishes in the vicinity of these structures. The common grazing fishes present around platforms included the red snapper *Lutjanus campechanus*, mangrove snapper *Lutjanus griseus*, a grouper, blue runner *Caranx crysos*, bull shark *Carcharhinus leucas*, blenny *Hypleurophilus geminatus*, ocean trigger fish *Canthidermis sufflamen*, Atlantic spade fish *Chaetodipterus faber*, and the striped sheepshead *Archosargus probatocephalus*. Fishes were not commonly seen grazing on the fouling growth within the bottom turbid (= nepheloid) layer.

The reef effect possibly promotes the standing stock of fish populations or perhaps merely dislocates the fish concentrations. Added studies are needed to characterize the reef effect of platforms and to determine the long-term biological impact of attracting the colonization of species from other adjacent or distant provinces.

Gunter and Geyer studied the fouling community on four oil platforms off the Louisiana coast in 1951-1953, two of which are within the present study area of the OEI. These two Exxon oil platforms within the same area were chosen for a comparative study. We have interpreted Gunter and Geyer's data in our tables 5 and 6.

Table 4

Qualitative Occurrence of Fouling Organisms Present
On Oil Platforms in the O.E.I. Area, Louisiana
June 1972 - July 1973

m = motile s = sessile

Species	Timbalier Bay	Nearshore	Offshore
Phylum Chlorophyta			
Enteromorpha sp. (s)	X	X	X
Phylum Rhodophyta			
Polysiphonia sp. (s)	X	X	
Phylum Porifera			
sponge, unidentified (s)			X
Phylum Coelenterata			
Bougainvillia tennella (s)		X	
Bundosoma cavernata (s)		X	
Astrangia astreiformis (s)			X
Phylum Platyhelminthes			
Leptoplana sp. (m)	X		
Phylum Annelida			
Nereis sp. (m)	X		
Neanthes succinea (m)	X	X	X
Eunice subra (m)	X		
Pomatoceros sp. (s)		X	
Phylum Mollusca			
Ostrea equestris (s)		X	
Lithophaga aristata (s)		X	
Crassostrea virginica (s)	X	X	
Mitrella sp. (m)		X	
Phylum Arthropoda-Crustacea			
Copepoda			
Lapidocera aestiva (m)		X	
Acartia tonsa (m)		X	
Cirripeda			
Balanus reticulatus (s)	X	X	X
Balanus eberneus (s)		X	X
Lepas sp. (s)			X
Amphipoda			
Hemiaegina sp. (m)		X	
Stenothoe sp. (m)		X	
Corophium sp. (m)	X	X	
Caprella sp. (m)	X	X	
Tanaidacea			
Tanaid, unidentified (m)		X	
Isopoda			
Sphaeroma quadridentatum (m)	X		
Limnoria tripunctata (m)	X		
Decapoda			
Synalphaus townsendi (m)		X	
Neopanope texana (m)		X	X
Pilumus pannosus (m)		X	X
Eurypanopeus abbreviatus (m)	X	X	X
Phylum Ectoprocta			
Bugula neritina (s)		X	
Acanthodesia sp. (s)			X
Phylum Echinodermata			
Arbacia punctulata (m)		X	X
Phylum Chordata			
ascidian, unidentified (s)			X
Number of Species	13	25	13

Table 5

Faunal List of Fouling Assemblage off the Louisiana Coast
Tabulated from Gunter and Geyer (1955)

Species	Relative Abundance	Optimum Depth (meters below surface)	Depth Range (meters below surface)
Algae	++	0-0.6	0-0.6
Phylum Coelenterata			
Astrangia asteriformis	+	9.1	5.2-14.6
Anthopleura krebsi	+++	9.4-14	surface-bottom
Aiptasia pallida	+++	0.6-5.2	surface-bottom
hydroids	+++	0.6-5.2	surface-bottom
Phylum Annelida			
Eupomatus	+	bottom	bottom
Phylum Mollusca			
Crepidula	rare	bottom	9.4-14
Pteria eolymbus	rare	9.4	9.4
Arca transversa	rare	14	14
Ostrea equestris	rare	14.6	9.4-14.6
Crassostrea virginica	rare	0.6	0.6
Thais haemostoma	rare	5.2	0.6- 7.9
Phylum Arthropoda-Crustacea			
Cirripedia			
Balanus improvisus	+++	0.6-9.4	surface-bottom
Balanus amphitrite	rare	1.2	1.2
Amphipoda			
Corophium	+++	0.6-5.2	surface-bottom
Decapoda			
Menippe	rare	1.2	1.2
Phylum Ectoprocta			
Aeanthodesia	+	bottom	surface-bottom

+++ = Abundant, ++ = Common, + = Present, rare = Less than 10 individuals observed.

These data reflect three apparent differences between the climax fouling community now and two decades ago: (1) the composition of the motile components, (2) the presence of sponges in the 1973-74 study, and (3) the presence of the barnacle *Balanus reticulatus*. The first two differences are possibly due to sampling technique, and the third due to the introduction of the barnacle *B. reticulatus* into the Gulf of Mexico, perhaps as a consequence of increased shipping operations in the past two decades.

The fouling samples in the present study were collected with an *in situ* scraping device that collected both sessile and motile species. Gunter and Geyer suspended steel cylinders from a platform and retrieved them from the surface, allowing the escape of the motile animals such as

Table 6

Faunal List of Fouling Assemblage off the Louisiana Coast
From Exxon 22 "L" and Exxon 18 "A"

Species	Relative Abundance	Optimum Depth (meters below surface)	Depth Range (meters below surface)
Algae			
Enteromorpha	++	0- 0.3	0- 4.6
Phylum Porifera			
Cliona	+++	4.6- 7.6	3-10.7
Lissodendoryx	+	4.6- 7.6	3-10.7
Phylum Coelenterata			
Aiptasia pallida	+++	3- 7.6	5-10.7
Astrangia asteriformis	rare	12.8	12.8
hydroids	+++	surface	surface-bottom
Phylum Annelida	+++	6.1- 9.1	surface-bottom
Phylum Mollusca			
Crassostrea virginica	rare	0- 3	0- 4.6
Ostrea equestris	rare	7.6-10.7	6.1-10.7
Thais haemostoma	rare	9.1	7.6-10.7
Phylum Arthropoda-Crustacea			
Copepoda			
Labidocera aestiva	rare	0- 3	0- 9.1
Cirripedia			
Balanus reticulatus	+++	5- 9.1	surface-bottom
B. improvisus	++	5- 6.1	above 9.1
B. eburneus	rare	4.6	3- 9.1
B. tintinnabulum	rare	9.1	7.6-10.7
Isopoda	rare	12.8	10.7-13.7
Amphipoda			
Corophrium	+++	0- 6.1	0-10.7
Stenothoe	+++	0- 6.1	0- 9.1
Caprella	++	3- 9.1	0- 9.1
Decapoda			
Neopanope texana	+	3- 9.1	0-10.7
Eurypanopeus	+	3- 9.1	0-10.7
Phylum Ectoprocta			
Bugula neritina	+	2.4	3- 6.1
Membranipora	+	10.7	surface-bottom
Chordata			
Ascidian	+	6.1	3-10.7
Hypleurochilus	+	7.6	3-10.7

+++ = Abundant, ++ = Common, + = Present, rare = Less than 10 individuals observed.

amphipods. The difference in collecting techniques may explain the near absence of motile crustacea in the study by Gunter and Geyer (see table 5).

The absence of the sponge, *Cliona*, from Gunter and Geyer's work could be attributed to the duration of their experiment. The longest exposure period was 14 months from November 1950 to January 1952. Platform legs that had been exposed for 14 months (June 1972 to August 1973) had a significantly smaller amount of *Cliona* growth than was present on the older portion of the structure from which scraping samples were taken.

These results point out colonization of new species on the same platform, suggesting faunal change in the ensuing 20 years. The results also revealed the obvious influence of 1973 spring flood by promoting the invasion of less saline shore species into the near-shore and offshore environment. Evidently the shelf ecosystem in Louisiana coast is strongly influenced by the Mississippi drainage into the shelf.

Comparison of the results of this study and the Northeastern Gulf studies conducted by Pequegnat and Pequegnat is difficult because of geographic distinctions between the two regions. The fouling community in the Northeastern Gulf was found to be under the influence of East Gulf Loop current and apparently unaffected by the Mississippi River plume. A benthic "turbid layer" was not observed off the coast of Florida. One readily discernible difference is that the dominant biomass on the Louisiana platforms is made up of barnacles and hydroids, whereas in the Florida offshore locations the dominant organisms were sponges, corals, and tunicates. A recent photo-survey of offshore structures off Panama City also confirmed this distinction.

CONCLUSIONS

1. High standing stock and density of fouling on submerged oil platform structures offer feeding grounds for grazing fishes. Therefore, the oil platforms compare ecologically to artificial reefs.

2. The record spring flood in 1973 diluted the water, leading to invasion of shore fouling species into near-shore and offshore platforms and significantly enhancing the total standing stock of the fouling community.

3. Comparison of the climax community of fouling growth in the same Exxon platforms today and that of 20 years ago revealed faunal changes in association with environmental changes of ecological consequence. This points out the dynamic, not static, nature of the ecosystem.

4. Trends in both horizontal (distance from shore) and vertical (depth-related) variations in biomass and density distribution of the fouling community are evident.

5. The fouling in Louisiana oil platforms differs from known off-

shore fouling in Florida coast waters primarily because of hydrological conditions.

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